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(54) IMPROVEMENTS RELATING TO A SENSING PROBE FOR ATTACHMENT TO A BODY

(71) We, VICKERS LIMITED, a British Company, of P.O. Box 177, Vickers House, Millbank Tower, Millbank, London, SW1P 4RA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to a sensing probe for attachment to a body surface. The body can be a human body, for example, although the invention is applicable to inanimate bodies.

In the field of medicine, a number of parameters e.g. temperature, electrical potential, indicative of a patient's condition, can be measured by means of a sensor which in use is held against the skin of the patient. The sensor, its encapsulation or other mounting means, and electrical connections from the sensor which are to be connected to a recording instrument, comprise a probe.

It is usual for attachment of a probe to a patient's skin to be made by relatively simple means such as the use of sticking plaster. In many monitoring applications of a patient where monitoring needs to be carried out over an extended period of time, accidental detachment of the probe terminates the monitoring and could in some cases endanger the life of the patient, for example where the patient is a baby being nursed in an incubator in which the desired skin temperature is controlled in dependence upon the actual skin temperature as determined by a skin contacting probe. Clearly, it is desirable to provide a warning when the probe has become detached from the patient's skin.

According to a first aspect of the invention, there is provided a sensing probe for attachment to a suface of a body, comprising a pad for positioning on the body surface, a gas chamber provided with duct means to which a gas pressure may be applied, the pad and chamber being so constructed and arranged that a gas pressure other than ambient applied to the duct means produces a relative force between the pad and the said body surface, an electrical sensor arranged on a central part of the body contacting portion of the said pad, the sensor being provided with electrical connecting leads for connection to an external indicating device for providing an indication of a predetermined sensed condition of the body, and means to monitor, in use, a parameter of the gas in the probe which varies in dependence upon whether or not probe contact exists with the body surface and to provide an indication of whether such probe contacts exists from the monitored gas parameter.

According to a second aspect of the invention, there is provided a method of sensing a predetermined condition of a body, wherein a sensing probe incorporating a sensor on a central part of a body surface contacting portion of a pad of the probe is applied to the body surface to enable the sensor to sense the said condition, and wherein, in order to provide an indication of whether probe contact exists with the body surface, the probe includes a gas chamber which is provided with duct means to which a gas pressure may be applied and which chamber and pad are so constructed and arranged that a gas pressure other than ambient applied to the said duct means produces a relative force between the pad and body surface, and a parameter of the gas in the probe, which varies in dependence upon whether or not probe contact exists, is monitored and an indication provided of whether probe contact exists from the monitored gas parameter.

For a better understanding of the invention and to show how the same may be car-

ried into effect, reference will now be made, by way of example, to the accompanying, very diagrammatic, drawings, in which:–

Figure 1 illustrates one form of sensing probe in accordance with the invention, shown in vertical section,

Figure 2 shows a warning device for use in conjunction with the probe,

Figure 3 and 4 are views corresponding to Figure 1 showing two further embodiments, and

Figure 5 shows a modified warning device.

Referring to Figure 1, the probe shown at 1 comprises a stem 2 having at one end a skin contacting pad 3 which defines a suction manifold or chamber 4 connected by a suction line 5, running longitudinally through the stem 2, and by tubing 15 to a pump 10 (Figure 2) and to a warning device to be described with reference to Figure 2. Suction holes 6 lead from the peripheral region of the skin contacting portion of the pad 3 to the suction chamber 4. Arranged centrally of the suction holes on a part of the skin contacting pad portion is an electrical sensor 7 for sensing a predetermined condition at the surface of the skin, for example skin temperature, the sensor being provided with electrical connecting leads 8 which also pass through the stem 2 and are connected to a display unit which provides a display of the sensed skin condition.

In one mode of use, with the pad 3 positioned against the skin surface, suction is applied to the suction chamber 4 by the pump 10 and this produces a force urging the pad against the adjacent skin surface. Providing sufficient suction is applied, the probe is held firmly in place.

An an alternative to the suction holes, the skin contacting portion of the pad may be in the form of a porous plug whose pores communicate with the interior of the suction chamber.

Referring now to Figure 2, the warning device comprises a differential pressure transducer 9 connected to compare the pressure in the tubing 15, connecting the suction chamber of the probe to the suction pump 10, with the atmospheric pressure. An alarm unit 11 connected to the output of the transducer 9 is controlled by the transducer. Providing the pad of the probe is held in contact with the patient's skin, a pressure lower than atmospheric pressure is present in the tubing 15 and the alarm unit assumes a first state so as to indicate the existence of probe contact with the skin. If the probe should become detached from the patient, the pad of the probe will become exposed to the atmosphere and the resulting change in output signal from the transducer, due to the change of pressure in the tubing 15, causes the alarm unit 11 to operate so as to assume a second state indicating that probe contact with the patient's skin no longer exists.

A disadvantage with the Figure 1 embodiment is that, conceivably, the tubing 15 might become kinked, which could result in insufficient pressure reduction in the suction chamber to hold the probe in position on the patient's skin and yet the alarm unit 11 might not be operated because, owing to the kink, a lower than atmospheric pressure would exist between the kink and the differential pressure transducer, as would normally be the case. An embodiment which is improved in this respect is shown in Figure 3.

In this Figure, the probe is identical to that shown in Figure 1, except that a connecting passage 12 is formed in the wall of the pad 3 to provide direct communication between the suction chamber and the atmosphere. The size of the passage 12 is such that when suction is applied to the tubing 15 an adequate force is produced to hold the probe on the patient's skin. Nevertheless, because of the provision of the passage 12, the pressure in the tubing 15 is not as low as it would have been if the passage were not provided. Clearly, if the tubing 15 becomes kinked, the pressure detected by the differential pressure transducer will fall further. By making the transducer responsive to changes in pressure to values outside an intermediate pressure range chosen to suit the operating requirements of the probe, the alarm unit will be actuated both if the probe should become detached from the patient or if the tubing should become kinked.

To prevent the passage 12 becoming partially blocked, for example by a sheet or blanket, when the tubing 15 is unkinked, thus giving rise to the alarm unit being actuated, a duct 13 may be provided in the stem 2, communicating with the suction chamber and extending longitudinally of the stem, as shown in Figure 4. Tubing 14 is connected to the duct 13 and leads well clear of the patient to a place where there is no danger of the end of the tubing 14 being partially blocked..

As described hereinabove, detected changes in pressure in the tubing 15 are used to actuate the alarm unit but gas pressure is not the only parameter of the gas in the probe, varying in dependence upon whether or not probe contact exists with the patient's skin, which can be monitored to detect probe detachment. In the modification of Figure 5, flow rate changes are detected for the same purpose. Referring to this Figure, an anemometer 109 is connected in the tubing 15 to monitor the air flow rate in the suction line 5 and tubing 15. The anemometer responds to the change in flow rate if the

probe should become detached from the patient's skin and accordingly generates an output signal as an indication of such probe detachment. The output signal is amplified in an amplifier 12 and processed in a signal processor 113 to generate a control signal to actuate an alarm unit 114.

In the disclosed embodiments, the applied suction is used not only to hold the probe in position but also for actuating the alarm unit. In another mode of use, the primary function of the applied suction is merely for operation of the alarm unit and whilst some force will inevitably result from the reduced pressure in the suction chamber urging the probe against the patient's skin, the probe can be held in position mainly by conventional means, e.g. by sticking plaster. Moreover, rather than applying suction to the tubing 15 a gas pressure greater than atmospheric may be applied to the tubing and detachment of the probe from the patient is detected from the monitored gas pressure or flow rate in the tubing in a corresponding manner to that described above. Of course, the probe would need to be held on the patient's skin by means such as the use of sticking plaster since the increased gas pressure in the chamber in the pad of the probe would produce a force urging the pad away from the skin surface. Nevertheless, the applied gas pressure can be so set that adequate gas pressure or flow rate changes are established, following probe detachment, for easy detection with only a negligible force produced tending to separate the pad from the skin.

It will be appreciated that the invention is applicable to attaching probes to animals or to inanimate bodies, for example the surface of a sheet of metal whose temperature is to be monitored.

WHAT WE CLAIM IS;-

1. A sensing probe for attachment to a surface of a body, comprising a pad for positioning on the body surface, a gas chamber provided with duct means to which a gas pressure may be applied, the pad and chamber being so constructed and arranged that a gas pressure other than ambient applied to the duct means produces a relative force between the pad and the said body surface, an electrical sensor arranged on a central part of the body contacting portion of the said pad, the sensor being provided with electrical connecting leads for connection to an external indicating device for providing an indication of a predetermined sensed condition of the body, and means to monitor, in use, a parameter of the gas in the probe which varies in dependence upon whether or not probe contact exists with the body surface and to provide an indication of whether such probe contact exists from the monitored gas parameter.

2. A probe according to claim 1, wherein said parameter is the gas pressure in the duct means.

3. A probe according to claim 2, wherein the parameter monitoring and contact indicating means comprises a differential pressure transducer and an alarm unit connected to be operated by the transducer.

4. A probe according to claim 1, wherein said parameter is the gas flow rate through the duct means.

5. A probe according to claim 4, wherein the parameter monitoring and contact indicating means comprises an anemometer and an alarm unit connected to be operated by the anemometer.

6. A probe according to claim 5, wherein the parameter monitoring and contact indicating means further comprises an amplifier provided with a signal processor arranged to amplify and process, in use, the output signals from the anemometer and to control operation of the alarm unit.

7. A probe according to any preceding claim, wherein holes in the said pad lead from the peripheral region of the body contacting portion of the said pad to the chamber, also disposed in said pad.

8. A probe according to any one of claims 1 to 6, wherein the body contacting portion of the said pad is in the form of a porous plug of which the pores are in communication with the chamber.

9. A probe according to any preceding claim, comprising a stem having the said pad at one end.

10. A probe according to claim 9, wherein said duct means comprises a single passage extending longitudinally through the said stem in communication with said chamber.

11. A probe according to claim 10, when appended to claim 7 or 8, further comprising a connection, separate from said holes or said pores, as the case may be, to provide communication between said chamber and an ambient pressure.

12. A probe according to claim 11, wherein said connection extends from the said chamber directly to the exterior of the said pad.

13. A probe according to claim 12, wherein said connection comprises a duct extending longitudinally through said stem.

14. A sensing probe for attachment to a surface of a body, substantially as hereinbefore described with reference to any one of Figures 1, 3 and 4 taken in conjunction with Figure 2 or Figure 5 of the accompanying drawings.

15. A method of sensing a predetermined condition of a body, wherein a sensing probe incorporating a sensor on a central part of a body surface contacting portion of a pad of the probe is applied to the

body surface to enable the sensor to sense the said condition, and wherein, in order to provide an indication of whether probe contact exists with the body surface, the probe includes a gas chamber which is provided with duct means to which a gas pressure may be applied and which chamber and pad are so constructed and arranged that a gas pressure other than ambient applied to the said duct means produces a relative force between the pad and body surface, and a parameter of the gas in the probe, which varies in dependence upon whether or not probe contact exists, is monitored and an indication provided of whether probe contact exists from the monitored gas parameter.

16. A method according to claim 15, wherein said indication is provided by an alarm unit having two states only, respectively indicating the existence or absence of probe contact.

17. A method according to claim 15 or 16, wherein the said parameter is the gas pressure in the duct means.

18. A method according to claim 15 or 16, wherein the said parameter is the gas flow rate in the duct means.

19. A method according to any one of claims 15 to 18, wherein suction is applied to said duct means.

20. A method according to any one of claims 15 to 18, wherein gas above ambient pressure is applied to said duct means.

21. A method of sensing a predetermined condition of a body, substantially as hereinbefore described with reference to any one of Figures 1, 3 and 4 taken in conjunction with Figure 2 or 5 of the accompanying drawings.

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Sheet 1

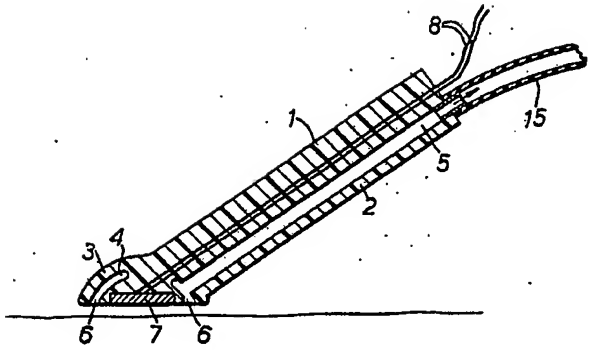

FIG.1.

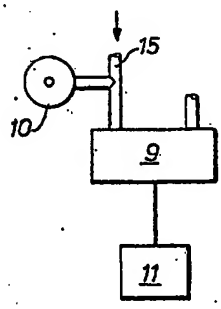

FIG.2.

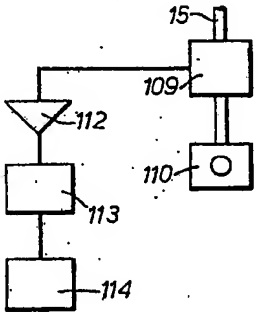

FIG.5.

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Sheet 2

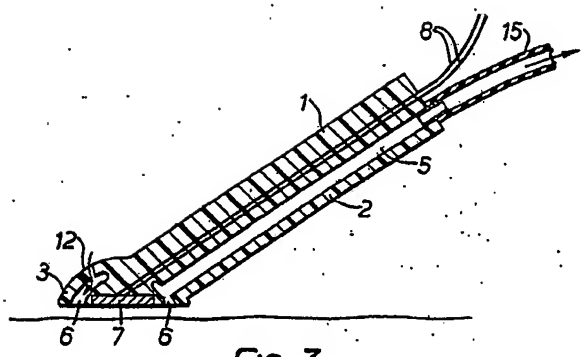

FIG. 3.

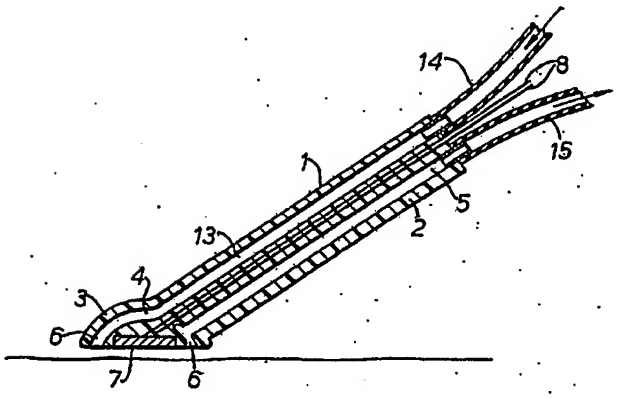

FIG. 4.